

APPLICATION
FOR
UNITED STATES LETTERS PATENT

**TITLE: METHOD OF CONTROLLING THE AUDITORY RESPONSE
 OF WIRELESS DEVICES**

APPLICANT: Thomas W. Humphrey, Larry D. Moore

ASSIGNEE: INTERNATIONAL BUSINESS MACHINES CORPORATION

Wood, Herron & Evans, L.L.P.
2700 Carew Tower
441 Vine Street
Cincinnati, OH 45202-2917
(513) 241-2324

SPECIFICATION

METHOD OF CONTROLLING THE AUDITORY RESPONSE OF
WIRELESS DEVICES

Field of the Invention

The present invention relates to control of personal wireless devices.

Cross-Reference to Related Application

- 5 The present application is related to application Serial No. __/_____,
filed on the same day as this application by Richard Dean Dettinger, et al., entitled
"Method of Handling Wireless Device Intrusion into Populated Areas", assigned to
the same assignee as the present application, and incorporated by reference herein in
its entirety.

Background of the Invention

- 10 The widespread use of cellular telephones, pagers, personal digital
assistants (PDAs) and other wireless devices has adversely affected group events
attended by people who use these devices. For example, attendees of large

professional conferences often must deal with presentations being interrupted by cellular telephones ringing or pagers and personal digital assistants (PDAs) going off. This detracts from the overall effectiveness of the presentation while simultaneously annoying other attendees.

5 This problem occurs in other settings as well. At a movie theater, a person carrying a cellular telephone is a likely disturbance. When the cellular telephone rings, the remaining theater goers are disturbed. Even if the owner leaves the movie theater to take the call, in the process of leaving the theater, the owner distracts and blocks the view of others.

10 An almost infinite number of similar scenarios may occur, where wireless devices interrupt proceedings in a wide variety of settings, such as theaters, concert halls, restaurants, meeting rooms, hospitals, and other similar public venues.

 In general, this problem persists in our culture not because people refuse to respect others, but rather because they simply forget to switch their devices
15 to a non-intrusive or silent mode of operation. Wireless devices have become so commonplace that people often forget they have them.

 As the widespread use of wireless devices has occurred only within the last several years, little effort has been put into preventing these devices from interrupting group events. Most of the attempts have been of the extremely “low
20 tech” variety. Perhaps the first and simplest attempts have been the use of signs outside meeting areas or reminders given at the beginning of movies or presentations. These attempts have perhaps had a small degree of success; but surely, the situation will not improve as the number of wireless device users continues to grow.

Another solution is to use a jamming transmitter. Jamming transmitters for this type of application will typically have several independent oscillators from which jamming signals can be generated to block the use of certain frequency ranges. These types of jamming transmitters are often referred to as

5 “barrage jammers.” The frequency ranges targeted are those used by paging devices as well as those used for call establishment by cellular/personal communication systems (PCS) systems. Thus, when activated in a designated area, a barrage jammer will prevent all pagers and mobile phones located in that area from receiving and transmitting calls by means of radio frequency (RF) interference. Barrage jammers

10 typically have poor frequency selectivity which leads to interference with a larger frequency bandwidth than that used by pagers and cellular/PCS systems.

Barrage jammers might be implemented without the cooperation from cellular/PCS providers, so long as there are adequate guard bands available. However, once jamming begins, counter-jamming may result, either by deliberate

15 action of providers, or more likely by autonomous response of power control systems within the PCS/cellular systems.

Another concern with barrage jammers is that they increase the RF noise floor in areas adjacent to their area of use. Many cellular/PCS systems are required to work in all types of buildings under very low signal conditions, and the

20 use of barrage jammers in the same band and vicinity, results in an increase in the noise floor that could mean the difference between receiving and not receiving a critical call. Due to these limitations, as well as others, barrage jammers are not particularly well suited to addressing the problem at hand.

Yet another solution is referred to as an intelligent cellular disabler.

Unlike barrage jammers, intelligent cellular disablers do not transmit an interference signal on the control channels. Rather, an intelligent cellular disabler, when located in a designated "quiet" area, functions as a detector. An intelligent cellular disabler will

5 have a unique identification number for communicating with the cellular network.

When an intelligent cellular disabler detects the presence of a mobile phone in the quiet area, the intelligent cellular disabler communicates the presence of the mobile to the cellular network which in turn prevents the authorization of call establishment. This, in effect, filters calls to mobiles through software.

10 Since an intelligent cellular disabler is a software-based solution, calls may be routed to the call recipient's voice mail box, provided they subscribe to a voice mail service. Similarly, the detector may exempt users who have designated emergency status. These users must preregister their phone numbers with the service providers. Thus, when an incoming call arrives, the detector recognizes the number

15 and the call is established for a specified maximum duration, e.g., two minutes. Users are also permitted to make outgoing calls routed to "911" type services.

Unlike barrage jammers, intelligent cellular disablers, being an integral part of the cellular/PCS systems, must be provisioned by the cellular/PCS service providers or by a third-party working cooperatively with full support of the

20 cellular/PCS service providers.

Yet another solution is referred to as an intelligent beacon disabler. Like intelligent cellular disablers, intelligent beacon disablers do not transmit an interference signal on the control channels. Intelligent beacon disablers are located in

a quiet area and function such that any compatible wireless device in the quiet area is instructed to disable its ring or disable its operation, while within the coverage area of the beacon. Obviously, only wireless devices which have a compatible receiver would respond to the beacon. The beacon receivers would typically be built on some
5 technology other than cellular or PCS, such as wireless paging, Bluetooth, etc. The Bluetooth standard, promulgated by Bluetooth SIG, Inc. ("Bluetooth") a not-for-profit trade association that promotes personal connectivity solutions based on the Bluetooth wireless technology. Accessible at the Internet address of www.bluetooth.org.

Intelligent beacon disablers do not cause interference or require any
10 cooperation from cellular/PCS providers. However, intelligent beacon disablers do require compatible wireless devices. As such, effective deployment will be problematic for many years.

Yet another solution is referred to as a direct receive and transmit jammer. This type of jammer behaves like a small, independent and portable base
15 station, which can directly interact intelligently or unintelligently with the operation of the local mobile phone. The jammer is predominantly in a receiving mode and will intelligently choose to transmit and block wireless devices if they are within close proximity of the jammer, thereby creating a quiet area.

This selective jamming technique uses a discriminating receiver to
20 target the jamming transmitter. The benefit of such target selectivity is much less electromagnetic pollution in terms of raw power transmitted from and bandwidth used by the jammer. Therefore, this type of jammer is much less disruptive to passing

traffic. The jammer only transmits long enough to prevent a cellular telephone from linking with the cellular/PCS network. Otherwise, no transmission occurs.

Selective jamming could be implemented without the cooperation of cellular/PCS providers, but could also negatively impact cellular/PCS operation. Like
5 intelligent cellular disablers, this solution could be made to discriminate 911 calls and allow for "breakthroughs" during emergencies.

Still another solution uses electromagnetic interference (EMI) shielding. This solution uses EMI shielding techniques to make a room into what is known as a Faraday cage. Although labor intensive to construct, a Faraday cage
10 essentially blocks, or greatly attenuates, virtually all electromagnetic radiation from entering or leaving the cage, that is, the quiet room.

With the current state of the art in EMI shielding techniques, and commercially available products one could conceivably implement a Faraday cage into the architecture of newly designed buildings for so-called "quiet conference"
15 rooms. Unfortunately, all calls, including emergency calls, would be blocked, unless there were provisions to receive and decode emergency transmissions and then feed them through the cage to be retransmitted. Obviously this is an expensive and long term solution.

Governmental regulatory agencies may ultimately determine which one
20 of these solutions is best to use or not to use. For example, in the United States, FCC Rule Part 15(5b) precludes the use of intentional interferers. Canada, the United Kingdom, Australia, France, and Japan all have similar prohibitions on jamming devices, although they are under evaluation in some countries.

It can thus be seen that, in light of current governmental regulations prohibiting the use of jamming devices, there is increasing need for a method of preventing the interruption of group events attended by people who use cellular telephones, pagers, PDAs, and other wireless devices.

5

Summary of the Invention

The present invention resolves the problems of interruptions caused by wireless communications devices, in a manner which is autonomous, i.e., does not require arrangement of equipment other than the wireless devices themselves.

10 More specifically, wireless devices are configured to network together when in close proximity with each other, measure the relative sound pressure level of their environment, and modify the auditory response of the wireless device based on established parameters. Thus, for example, the wireless device may detect when it is in a quiet room with multiple other devices, which is indicative of a meeting that
15 should not be disturbed.

The above and other objects and advantages of the present invention shall be made apparent from the accompanying drawings and the description thereof.

Brief Description of the Drawings

20 The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with a general description of the invention given above, and the detailed description of the embodiments given below, serve to explain the principles of the invention.

Fig. 1 is an illustration of variety of wireless devices networked together including a plurality of cellular telephones, a palm device, and a palm computer.

Fig. 2 illustrates an exemplary wireless device.

5 Fig. 3 illustrates an alternative embodiment of the present invention combining the functionality of the cellular telephone and palm device of Fig. 1.

Fig. 4 is a flow chart for an application illustrating activities of a wireless device in accordance with an aspect of the present invention.

Detailed Description of Specific Embodiments

10 Turning to the Drawings, wherein like numbers denote like parts throughout the several views, Fig. 1 illustrates a network computing environment 10 consistent with principles of the present invention. As shown, various wireless devices are connected to a network 12 so that the devices are capable of communicating with one another. As also shown, a plurality of cellular telephones
15 14, a personal digital assistant (PDA) 16, and a palm computer 18 typify exemplary wireless devices. Network 12 may be implemented using Bluetooth or some other comparable networking protocol which provides similar functionality.

As seen in Fig. 1, the wireless device may take a variety of forms 14, 16, 18, but the functional elements of each wireless device take the general form
20 shown in Fig. 2. As shown in Fig. 2, the typical wireless device includes a processor 30 capable of executing code, a memory 34 for storing code for the processor, a keypad 38, a display 40 and a communications interface 36. A microphone 42 and/or

a speaker 44 may be included. Each of these elements is interconnected such as via a bus 32. The processor is capable of networking with another wireless device through communication interface 36. Users of the typical wireless device are able to interact with the program embodied in the code 34 executed by processor 30, through keypad 5 38 and a display 40, or alternatively microphone 42 and/or speaker 44. This typical configuration allows a user to make a selection, which modifies the auditory response of another wireless device networked with the typical wireless device. Exemplary code may include applications and operating systems such as PalmOS. However, other operating systems could provide similar functionality without departing from the spirit of the invention.

For example, turning once again to Fig. 1, suppose a user has scheduled a meeting from 1:00pm to 2:00pm on Tuesday, November 19, 2002 on a personal digital assistant 16, such as a Palm Pilot, using the calendar function in PalmOS code resident in memory 34 and executed by processor 30. In scheduling the 15 meeting, the user may be prompted to select a behavior modification for the user's cellular telephone 14. Further suppose that in this particular instance, the user was prompted and selected shutting off the ringer. The personal digital assistant 16 then networks with the cellular telephone 14 using, e.g., Bluetooth, so that the auditory response of the cellular telephone 14 is modified based on the user selection in the 20 personal digital assistant. Thus, in this example, on Tuesday, November 19, 2002 from 1:00pm to 2:00pm, the ringer of the cellular phone 14 will be shut off. Such modifications of the auditory behavior of wireless devices may include, but are not

limited to, shutting off the ringer, silent mode, suppression of all but emergency communications, and/or an automatic response sent to callers.

Alternate forms of the invention are also possible. For example, the functionality of the cellular telephone 14 and personal digital assistant 16 could be combined into a single wireless device with calendaring functions. In this embodiment, networking between devices is not required. Fig. 3 illustrates such an embodiment. The functionality of the receiver and transmitter portion of the cellular telephone is realized in receiver 50 and transmitter 52, which receive and transmit through antenna 54. Once again the input/output functionality is provided by a keypad 36, a display 38, a microphone 42, and a speaker 44. Similarly, a processor 30 executes code resident in memory 34 whereby a user may, through a scheduling application, modify the auditory response of the speaker 44 associated with cellular telephone portion of the device during some time period.

As previously described in conjunction with Fig. 1, wireless devices may be configured to network together. As the number of devices networked together begins to increase, at some point it becomes reasonable to conclude that a user with a particular wireless device is in a crowded area. Having reached this conclusion, only one piece of additional information is necessary to determine whether or not to modify the auditory response of that particular wireless device. That piece of information is available by sampling the microphone of the wireless device. If the sample from the microphone indicates that the wireless device is in a noisy area, then no action will be taken to modify the auditory response of the device. An example of this circumstance may be a crowded city street. However, if the sample from the microphone does not

indicate that the wireless device is in a noisy area, then the auditory response of the device is modified. An example of this circumstance might be a professional conference or seminar.

Turning now to Fig. 4, a flow chart of an application for a wireless device in accordance with this aspect of the present invention is illustrated. The wireless device begins by networking with other devices in step 60. Each time the wireless device establishes or loses connectivity with another device a counter is incremented or decremented, respectively, in step 62. Thus, the counter maintains a current count of the number of the devices the wireless device is networked with.

In step 64, a comparison is made between the count and a threshold number of devices. The threshold number of devices, e.g., X, is input in step 66 and may be downloaded via a wireless provider or coded into the application.

If the number of devices the wireless device is networked with is less than the threshold X, the wireless device continues networking with other devices.

However, if the number of devices exceeds the threshold X, a sample is taken from the wireless device microphone in step 68. The sample represents the sound pressure level of the environment the wireless device is currently in.

In step 70, the sample is compared to a sound pressure level threshold, e.g., Y. The sound pressure level threshold may also be downloaded via the wireless provider or coded into the routine, as shown in step 72. If the sample sound pressure level exceeds the threshold Y, the wireless device takes no further action, and continues networking with other devices. Thus, the low sound pressure level indicates that the wireless device is in a crowded noisy environment and no

modification to the auditory response of the wireless device is necessary. However, if the sample sound pressure level is less than the threshold Y, the wireless device is determined to be a crowded quiet environment and the auditory response should be modified so as not to disturb others.

5 Step 74 shows the modification of the auditory response. The auditory response modification may be based on a selection provided by the wireless provider or alternatively, the wireless device user may be able to select from a menu of modifications. Again, such modifications include, but are not limited to, shutting off the ringer, silent mode, suppression of all but emergency communications, and/or an
10 automatic response sent to callers.

 While the present invention has been illustrated by a description of various embodiments and while these embodiments have been described in considerable detail, it is not the intention of the applicants to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and
15 modifications will readily appear to those skilled in the art. For example, while the present invention has been described in the context of various wireless devices, those skilled in the art will appreciate that the mechanisms of the present invention are capable of being distributed as a program product in a variety of forms, such as a program for a wireless device such as a PDA using Palm OS or another operating
20 system, and that the present invention applies equally regardless of the particular type of signal bearing media to actually carry out the distribution. Examples of signal bearing media include: recordable type media such as floppy disks (*e.g.*, a floppy disk) and CD ROMS, and transmission type media such as digital and analog

communication links, including wireless communication links. The invention in its broader aspects is therefore not limited to the specific details, representative apparatus and method, and illustrative example shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of

- 5 applicant's general inventive concept.

What is claimed is:

11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039
1040
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1051
1052
1053
1054
1055
1056
1057
1058
1059
1060
1061
1062
1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
1081
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
1131
1132
1133
1134
1135
1136
1137
1138
1139
1140
1141
1142
1143
1144
1145
1146
1147
1148
1149
1150
1151
1152
1153
1154
1155
1156
1157
1158
1159
1160
1161
1162
1163
1164
1165
1166
1167
1168
1169
1170
1171
1172
1173
1174
1175
1176
1177
1178
1179
1180
1181
1182
1183
1184
1185
1186
1187
1188
1189
1190
1191
1192
1193
1194
1195
1196
1197
1198
1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239
1240
1241
1242
1243
1244
1245
1246
1247
1248
1249
1250
1251
1252
1253
1254
1255
1256
1257
1258
1259
1260
1261
1262
1263
1264
1265
1266
1267
1268
1269
1270
1271
1272
1273
1274
1275
1276
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
1325
1326
1327
1328
1329
1330
1331
1332
1333
1334
1335
1336
1337
1338
1339
1340
1341
1342
1343
1344
1345
1346
1347
1348
1349
1350
1351
1352
1353
1354
1355
1356
1357
1358
1359
1360
1361
1362
1363
1364
1365
1366
1367
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377
1378
1379
1380
1381
1382
1383
1384
1385
1386
1387
1388
1389
1390
1391
1392
1393
1394
1395
1396
1397
1398
1399
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
1416
1417
1418
1419
1420
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435
1436
1437
1438
1439
1440
1441
1442
1443
1444
1445
1446
1447
1448
1449
1450
1451
1452
1453
1454
1455
1456
1457
1458
1459
1460
1461
1462
1463
1464
1465
1466
1467
1468
1469
1470
1471
1472
1473
1474
1475
1476
1477
1478
1479
1480
1481
1482
1483
1484
1485
1486
1487
1488
1489
1490
1491
1492
1493
1494
1495
1496
1497
1498
1499
1500
1501
1502
1503
1504
1505
1506
1507
1508
1509
1510
1511
1512
1513
1514
1515
1516
1517
1518
1519
1520
1521
1522
1523
1524
1525
1526
1527
1528
1529
1530
1531
1532
1533
1534
1535
1536
1537
1538
1539
1540
1541
1542
1543
1544
1545
1546
1547
1548
1549
1550
1551
1552
1553
1554
1555
1556
1557
1558
1559
1560
1561
1562
1563
1564
1565
1566
1567
1568
1569
1570
1571
1572
1573
1574
1575
1576
1577
1578
1579
1580
1581
1582
1583
1584
1585
1586
1587
1588
1589
1590
1591
1592
1593
1594
1595
1596
1597
1598
1599
1600
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
1625
1626
1627
1628
1629
1630
1631
1632
1633
1634
1635
1636
1637
1638
1639
1640
1641
1642
1643
1644
1645
1646
1647
1648
1649
1650
1651
1652
1653
1654
1655
1656
1657
1658
1659
1660
1661
1662
1663
1664
1665
1666
1667
1668
1669
1670
1671
1672
1673
1674
1675
1676
1677
1678
1679
1680
1681
1682
1683
1684
1685
1686
1687
1688
1689
1690
1691
1692
1693
1694
1695
1696
1697
1698
1699
1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
1725
1726
1727
1728
1729
1730
1731
1732
1733
1734
1735
1736
1737
1738
1739
1740
1741
1742
1743
1744
1745
1746
1747
1748
1749
1750
1751
1752
1753
1754
1755
1756
1757
1758
1759
1760
1761
1762
1763
1764
1765
1766
1767
1768
1769
1770
1771
1772
1773
1774
1775
1776
1777
1778
1779
1780
1781
1782
1783
1784
1785
1786
1787
1788
1789
1790
1791
1792
1793
1794
1795
1796
1797
1798
1799
1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1830
1831
1832
1833
1834
1835
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100
2101
2102
2103
2104
2105
2106
2107
2108
2109
2110
2111
2112
2113
2114
2115
2116
2117
2118
2119
2120
2121
2122
2123
2124
2125
2126
2127
2128
2129
2130
2131
2132
2133
2134
2135
2136
2137
2138
2139
2140
2141
2142
2143
2144
2145
2146
2147
2148
2149
2150
2151
2152
2153
2154
2155
2156
2157
2158
2159
2160
2161
2162
2163
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
2192
2193
2194
2195
2196
2197
2198
2199
2200
2201
2202
2203
2204
2205
2206
2207
2208
2209
2210
2211
2212
2213
2214
2215
2216
2217
2218
2219
2220
2221
2222